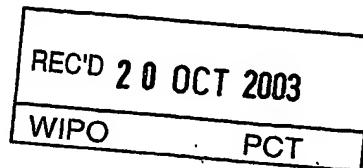


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# Kongeriget Danmark

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Title: Computer Vision and Tracking System.

IPC: -

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.



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PATENT- OG VAREMÆRKESTYRELSEN

## Modtaget PVS

27 AUG, 2002

[0001] The present invention is a real-time computer vision and tracking system to automatically locate and measure the size and quality of individual hard and softwood logs, pieces of industrial wood, and boards, hereinafter logs.

[0002] This system is to rationalize, and increase efficiency and measurement accuracy throughout the wood procurement process. Further, the precise tracking of the logs allows for accurate documentation in e.g., pursuit of wood certification.

[0003] By a computer vision system is understood a single or a series of computer sensor systems with integrated GPS. The vision system locates and measures the logs at several stages of some wood procurement process. The results of one or more of these measurements are to be used independently or in conjunction to give precise and unbiased estimates of position, size and quality of logs at any specific stage.

[0004] By tracking is understood a record of the positions of a recognized log along the procurement process where the system is applied e.g., the positions of a specific log from felling to any stage along the procurement process where the system is no longer applied.

[0005] The system will satisfy different immediate demands for information of various actors along the procurement process. In particular: i) buyers and sellers demand for accurately measured and classified trading units and documentation hereof, and ii) the need to back-track logs and other wood commodities to their origin in the forest for certification purposes.

[0006] Further, the information collected by the system up to any given stage (operation) of the procurement process can be utilized for optimization purposes in subsequent stages of the procurement process. This increases the efficiency of the procurement process.

[0007] A schematic representation of the wood procurement process is shown in Figure 1. The action pattern of logs being loaded and unloaded by similar devices e.g., cranes, is repeated at all operations throughout the procurement process. Therefore the system is designed to apply similar computer sensor systems and similar image analysis algorithms at all stages.

[0008] Typically logs are traded at one or more of the operations listed in Figure 1. Thus the unit for trade is a varying collection of logs and the system is designed to compute aggregate values for such collections of logs.

[0009] The system can be applied at any action or set of actions e.g., an operation listed in Figure 1. In consequence it is the responsibility of buyers and sellers to decide on what stages it is appropriate to apply the system. Back-tracking boards to their origin in the forest does naturally require the system being applied at most unload and load points (actions).

[0010] The present invention suggests measuring individual logs using a stereo vision system integrated with GPS. The GPS system provides the location in space of the equipment that handles the logs and the vision system. Combined with automatic recognition of the logs in imagery captured by the vision system the path of each individual log can be mapped to provide tracking of the logs.

[0011] The core idea of the vision system is that it captures imagery of the logs during load/unload actions. During these actions only a few logs are handled at a time by a crane or similar device. Imagery of a bundle of few logs allows for a complete recognition of each individual log in the bundle. Candidate mount points of vision system are e.g., grab on harvester or forwarder, body of harvester or forwarder, truck at plant or any other place where the logs can be seen from vision system.

[0012] Further, imagery of the stacks (collections of logs) that are being loaded or unloaded are captured continuously to monitor exactly where each bundle of logs are placed or taken from. In this way stacks are considered cohorts of individual logs with their individual properties such as transportation path and size. Thus aggregate quantities and distributional statistics at the stack level can be computed to characterize a stack.

[0013] The idea of measuring logs on the fly by remote sensing and stacks being cohorts of logs with an associated record of information at the log level is an advance compared to today's practices. Common practice is to measure stacks in a separate process and characterize stacks by their outer measure and other aggregate quantities.

[0014] Each individual log is being monitored several times during the procurement line. At any load/unload action stereo imagery of each log while located in the unload stack, the crane and the load stack is being captured. This comprehensive information source forms the basis of an image analysis algorithm to estimate the size and location of the logs with a high level of accuracy. Integrating imagery across several operations in Figure 1 in the image analysis adds to the level of accuracy that can be obtained.

[0015] The image analysis algorithm is designed to adopt information from many sources. Hence the algorithm allows data fusion from sources such as field inventory, harvester, regional prior information on size and quality, and information dynamically gathered during a forest operation to ensure self-calibration.

[0016] An important by-product of the real-time implementation of the system is that the influence of decay and other biological factors can be quantified. Especially if there is a time-lag between the creation of a stack and it being picked up, using the system at both of these operations makes it possible to monitor changes in the stack.

[0017] The present invention is considered applicable for other industrial uses where 3D objects are being handled in a similar repeated load/unload fashion in stacks.

Operation	Action
Forest inventory / marking	Forest resource survey
Felling	Felling
	Delimbing and cross-cutting
	Log dump in terrain
Forwarding	Loading from terrain
	Stacking on forwarder
	Unloading in stack at forest road
Transportation by truck	Loading from stack at forest road
	Stacking on truck
	Unloading in stack at plant
Wood industry	Load logs to saw or pulp mill
	Sorting and storing boards

Figure 1: Conceptual chart of wood procurement process.

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Modtaget PVS

27 AUG. 2002

CLAIMS

1. A method for determining a volume of a stack of objects, comprising the steps of:
  - capturing an electronic image of the stack,
- 5 .. electronically processing the image to obtain a set of data representative of the volume of the stack.
  
2. A system for determining a volume of a stack of objects, comprising:
  - a camera system for capturing an electronic image of the stack,
- 10 .. a computer system operatively connected to or incorporated in the camera system, a data interface for transmitting the image or data derived from the image to the computer system,
- the computer system being programmed to electronically process the image to obtain a set of data representative of the volume of the stack.

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